Engineering Statement

1 Introduction

Together with the accompanying Schedule S and GXT files, Intelsat License LLC ("Intelsat") herein demonstrates that it is technically qualified to hold the authority sought in this modification application to operate the Galaxy 33 satellite at 133.0° W.L. The updated characteristics of the satellite, as well as its compliance with the various provisions of Part 25 of the Federal Communications Commission's ("FCC" or "Commission") rules,[1] are provided in the remainder of this Engineering Statement.

2 Spacecraft Overview

Galaxy 33 has the capability to operate in the frequencies listed in the table below. Intelsat is not seeking authority to operate in the 17700-17800 MHz, 19300-19630 MHz, and 29100-29250 MHz (grayed out in the below table).

Direction	Frequency[2]
Uplink	5925-6425 MHz
	13750-14500 MHz
	27500-28600 MHz[3]
	28600-29100 MHz[4]
	29100-29250 MHz
	29250-30000 MHz[5]

[1] Unless otherwise stated, all references to rule sections in this document refer to sections in Title 47 of the Code of Federal Regulations.

[2] As the bands 17700-17800 MHz, 19300-19630 MHz, and 29100-29250 MHz are all between two operational bands, the Schedule S includes the satellite specification for these bands as part of two larger bands.

[3] Intelsat is aware that the 27.5-28.35 GHz band is secondary for geostationary satellite orbit ("GSO") Fixed Satellite Services ("FSS") and is subject to Section 25.136. *See* 47 C.F.R. § 25.202(a)(1)(i).

[4] Intelsat is aware that GSO FSS is secondary to non-geostationary satellite ("NGSO") FSS in the 28.6-29.1 GHz frequency band. *See* 47 C.F.R. § 2.106, NG165.

[5] The 29.25-29.50 GHz band is allocated to NGSO mobile-satellite service ("MSS") feeder links and FSS on a co-primary basis. Earth station uplink operation in

Downlink	3700-4200 MHz[6]
	11450-12200 MHz
	17700-17800 MHz
	17800-18800 MHz[7]
	18800-19300 MHz[8]
	19300-19630 MHz
	19630-20200 MHz

The spacecraft provides the following coverage:

Frequency band	Beam	Coverage
C-band	Steerable	United States
Ku-band	Steerable	North America
Ka-band	Steerable	Contiguous United States and Alaska

2.1 Spacecraft Characteristics

Galaxy 33 is a Northrop Grumman Space Systems GEOStar 3 three-axis stabilized type spacecraft that has a rectangular outer body structure. Galaxy 33 utilizes two deployable solar array wings and a number of deployable and non-deployable antennas.

The Galaxy 33 spacecraft is composed of the following subsystems:

1) Thermal;
2) Power;
3) Attitude Control;

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this band will require coordination with the incumbent MSS feeder link operators. *See* 47 C.F.R. § 2.106, NG535A.

[6] With the exception of the telemetry, tracking, and command frequencies ("TT&C"), Intelsat is only seeking authority to operate in the 4000-4200 MHz downlink band in the contiguous United States. Outside of the contiguous United States, Intelsat is seeking to operate in the entire 3700-4200 MHz band. *See* Expanding Flexible Use of the 3.7 to 4.2 GHz Band, Report and Order and Order of Proposed Modification, FCC 20-22, 35 FCC Rcd 2343, ¶ 152 (2020); 47 C.F.R. § 2.106, NG182.

[7] Intelsat is aware that the band 17.8-18.3 GHz is primary for fixed services and secondary for FSS. *See* 47 C.F.R. § 2.106, US334.

[8] Intelsat is aware that the 18.8-19.3 GHz frequencies are primary for NGSO FSS and secondary for GSO FSS. *See* 47 C.F.R. § 2.106, NG165.

4) Propulsion;
5) TT&C;
6) Uplink Power Control ("ULPC"); and
7) Communications.

These subsystems maintain the correct position and attitude of the spacecraft, ensure that all internal units are maintained within the required temperature range, and ensure that the spacecraft can be commanded and controlled with a high level of reliability from launch to the end of its useful life. The spacecraft design incorporates redundancy in each of the various subsystems in order to avoid single-point failures.

The structural design of Galaxy 33 provides mechanical support for all subsystems. The structure supports the communication antennas, solar arrays, and the thrusters. It also provides a stable platform for preserving the alignment of critical elements of the spacecraft.

2.2 Communication Subsystem

The Galaxy 33 frequencies, polarization, and channel plan as well as the coverage contours and performance characteristics are provided in Schedule S. Exhibits 1 and 2 provide the beam parameters for the C-, Ku-, and Ka-band uplink and downlink beams, respectively, and Exhibit 3 provides the Schedule S beam designations.

2.3 TT&C Subsystem

The TT&C subsystem provides the following functions:

1) Acquisition, processing and transmission of spacecraft telemetry data;
2) Reception and retransmission of ground station generated ranging signals; and
3) Reception, processing and distribution of telecommands.

Galaxy 33 is equipped with 2 tunable command receivers and 2 tunable telemetry transmitters. The center command frequency on each receiver and transmitter is selectable via ground command in 100 kHz steps within the 3700-4200 MHz (space-to-Earth) and 5925-6425 MHz (Earth-to-space) frequency ranges.

The satellite's command and telemetry channel frequencies and performance are shown in Exhibit 4. The coverage patterns of the command and telemetry beams have gain contours that vary by less than 8 dB across the surface of the Earth and, accordingly, the gain at 8 dB below the peak falls beyond the edge of the Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A), contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S.

2.4 ULPC Subsystem

Galaxy 33 utilizes one C-band channel for ULPC, antenna tracking, and ranging. The coverage patterns of the ULPC beams have gain contours that vary by less than 8 dB across the surface of the Earth, and accordingly the gain at 8 dB below the peak falls beyond the edge of the Earth. Therefore, pursuant to Section 25.114(c)(4)(vi)(A), contours for these beams are not required to be provided and the associated GXT files have not been included in Schedule S. The Galaxy 33's ULPC frequency and subsystem performance are summarized in Exhibit 3.

2.5 Satellite Station-Keeping

The satellite will be maintained within 0.05° of its nominal longitudinal position in the east-west direction in compliance with Section 25.210(j).

The attitude of the spacecraft will be maintained with accuracy consistent with the achievement of the specified communications performance, after taking into account all error sources (i.e., attitude perturbations, thermal distortions, misalignments, orbital tolerances, and thruster perturbations, etc.).

3 Services

Galaxy 33 is a general-purpose communications satellite and has been designed to support various services offered within the Intelsat satellite system. Depending upon the needs of the users, the transponders on Galaxy 33 can provide a range of communications services including compressed digital video, high speed digital data, and digital single channel per carrier data channels.

4 Power Flux Density

The power flux density limits for space stations operating in C-, Ku-, and Ka-band are specified in Section 25.208. As provided in Schedule S, the Galaxy 33 transmissions do not exceed these limits.

5 Emission Compliance

Section 25.202(e) requires that the carrier frequency of each space station transmitter be maintained within 0.002% of the reference frequency. Galaxy 33 is designed to be compliant with the provisions of this rule.

Galaxy 33 will comply with the provisions of Section 25.202(f) with regard to emissions.

6 Orbital Location

Galaxy 33 has authority to launch and operate at the 133.0° W.L. orbital location. The 133.0° W.L. location satisfies Galaxy 33's requirements for optimizing coverage, elevation angles, and service availability. Additionally, the location also ensures that the maximum operational, economic, and public interest benefits will be derived.

7 Coordination Statement and Certifications

The downlink effective isotropic radiated power ("EIRP") density of the transmissions in the conventional C-band will not exceed 3 dBW/4kHz for digital transmissions or 8 dBW/4kHz for analog transmissions. The associated uplink transmissions will not

exceed applicable EIRP density envelopes in Sections 25.218 unless the non-routine uplink and/or downlink operation is coordinated with operators of authorized co-frequency space stations at assigned locations within six degrees of Galaxy 33 at 133.0° W.L.

8 Orbital Debris Mitigation Plan

Intelsat is proactive in ensuring safe operation and disposal of this and all spacecraft under its control. The four elements of debris mitigation are addressed below.

8.1 Spacecraft Hardware Design

Galaxy 33 is designed such that no debris will be released during normal operations. Intelsat has assessed the probability of collision with meteoroids and other small debris. In order to limit the effects of such unlikely collisions, critical satellite components are located inside the protective body of the satellite and are properly shielded. The satellite does not use any subsystems for end-of-life disposal that are not used for normal operations.

8.2 Minimizing Accidental Explosions

Intelsat has assessed the probability of accidental explosions during and after completion of mission operations. The satellite is designed in a manner to minimize the potential for such explosions. Propellant tanks and thrusters are isolated using redundant valves and electrical power systems are shielded in accordance with standard industry practices. At the completion of the mission and upon disposal of the spacecraft, Intelsat will ensure the removal of all stored energy on the spacecraft by depleting all propellant tanks, venting all pressurized systems and by leaving the batteries in a permanent discharge state.

8.3 Safe Flight Profiles

Intelsat has assessed and limited the probability of the space station becoming a source of debris as a result of collisions with large debris or other operational space stations.

Galaxy 33 and Galaxy 15 will be collocated at 133.0° W.L.[9] Intelsat will ensure that sufficient spatial separation is achieved between these two satellites through the use of orbit eccentricity and inclination offsets and thus minimize the risk of collision.

Intelsat is not aware of any other FCC-licensed system, or any other system applied for and under consideration by the FCC, having an overlapping station-keeping volume with Galaxy 33. Intelsat is also not aware of any system with an overlapping station-keeping volume with the satellite that is the subject of an International Telecommunication Union filing and that is either in orbit or progressing towards launch.

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[9] Galaxy 15 is permanently licensed at 133.0° W.L. but suffered an anomaly that ultimately caused the satellite to drift outside of its station-keeping box. *See* Intelsat License LLC, Request for Special Temporary Authority for Galaxy 15, File No. SAT-STA-20220818-00087 (granted Aug. 19, 2022).

8.4 Post-Mission Disposal

At the end of the mission, Intelsat will dispose of the spacecraft by moving it to an altitude of at least 253.8 kilometers above the geostationary arc. Intelsat has reserved 26 kilograms of hydrazine for that purpose.

In calculating the disposal orbit, Intelsat has used simplifying assumptions as permitted under the Commission's Orbital Debris Report and Order.[10] The effective area to mass ratio (Cr*A/M) of the Galaxy 33 spacecraft is 0.017 m^2/kg, resulting in a minimum perigee disposal altitude under the Inter-Agency Space Debris Coordination Committee formula of 253.8 kilometers above the geostationary arc. Accordingly, the Galaxy 33 planned disposal orbit complies with the FCC's rules.

The reserved propellant figure is an estimate. This figure is calculated taking into account the expected mass of the satellite at the end of life and the required delta-velocity to achieve the desired orbit.

9 TT&C Earth Stations

Intelsat will conduct TT&C operations through earth stations at one or more of the following teleports: Napa, California; Hagerstown, Maryland; Fillmore, California; Riverside, California; Castle Rock, Colorado; Brewster, Washington; Andover, Maine; Paumalu, Hawaii; and Ellenwood, Georgia. Additionally, Intelsat is capable of remotely controlling Galaxy 33 from its facilities in McLean, Virginia and Long Beach, California.

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[10] *Mitigation of Orbital Debris*, Second Report and Order, 19 FCC Rcd 11567 (2004).

Certification Statement

I hereby certify that I am a technically qualified person and am familiar with Part 25 of the Commission's rules. The contents of this engineering statement were prepared by me or under my direct supervision and to the best of my knowledge are complete and accurate.

/s/	August 22, 2022
Giselle Creeser Intelsat US LLC Director, Spectrum Policy and Engineering	Date

EXHIBIT 1
Communications Subsystem Uplink Beam Parameters

Beam Name	C-band	C-band	Ku-band Spot	Ku-band Spot	Ka-band Spot	Ka-band Spot
Schedule S Beam ID	CAHU	CAVU	KUHU	KUVU	KARU	KALU
Frequency Band (MHz)	5925-6425		13750-14500		27500-30000	27500-30000
Polarization	Horizontal	Vertical	Horizontal	Vertical	RHCP	LHCP
G/T (dB/K)	4.3	4.3	13.16	13.16	16.7	16.7
Minimum SFD--(dBW/m^2)	-101.3	-101.3	-106.16	-106.16	-105.7	-105.7
Maximum SFD--(dBW/m^2)	-76.3	-76.3	-79.16	-79.16	-82.7	-82.7

EXHIBIT 2
Communication Subsystem Downlink Beam Parameters

Beam Name	C-band	C-band
Schedule S Beam ID	CAHD	CAVD
Frequency Band (MHz)	3700-4200	
Polarization	Horizontal	Vertical
Maximum Beam Peak EIRP (dBW)	45.4	45.4
Maximum Beam Peak EIRP Density (dBW/4kHz)	5.9	5.9
Maximum Beam Peak EIRP Density (dBW/Hz)	-30.2	-30.2

Beam Name	Ku-band Spot	Ku-band Spot	Ka-band Spot	Ka-band Spot
Schedule S Beam ID	KUHD	KUVD	KARD	KALD
Frequency Band (MHz)	11450-12200		17700- 20200	
Polarization	Horizontal	Vertical	RHCP	LHCP
Maximum Beam Peak EIRP (dBW)	59.3	59.3	61.7	61.7
Maximum Beam Peak EIRP Density (dBW/4kHz)	11.8	11.8	10.3	10.3
Maximum Beam Peak EIRP Density (dBW/Hz)	-24.2	-24.2	-25.7	25.7

EXHIBIT 3
Beam Polarizations and GXT File Names

	Schedule S Beam GXT File Names							
	Linear Polarization				Circular Polarization			
Beam Description	**Uplink (H-Pol.)**	**Uplink (V-Pol.)**	**Downlink (H-Pol.)**	**Downlink (V-Pol.)**	**Uplink (LHCP)**	**Uplink (RHCP)**	**Downlink (LHCP)**	**Downlink (RHCP)**
C-band Beams								
C-band	CAHU	CAVU	CAHD	CAVD	----	----	----	----
ULPC1	----	----	----	----	----	----	----	UPC1*
Telemetry 1 Omni	----	----	----	----	----	----	TLMA*	----
Telemetry 1 Global	----	----	TLMB*	TLMC*	----	----	----	----
Telemetry 1 WCAs	----	----	----	----	----	----	TLMD*	----
Telemetry 2 Omni	----	----	----	----	----	----	TLME*	----
Telemetry 2 Global	----	----	TLMF*	TLMG*	----	----	----	----
Telemetry 2 WCAs	----	----	----	----	----	----	TLMH*	----
Command 1	CMD2*	CMD3*	----	----	----	CMD1*	----	----
Command 2	CMD5*	CMD6*	----	----	----	CMD4*	----	----
Ku-band Beams								
Ku-band Spot	KUHU	KUVU	KUHD	KUVD	----	----	----	----
Ka-band Beams								
Ka-band Spot	----	----	----	----	KALU	KARU	KALD	KARD

* *GXT files are not provided for the indicated beams because their -8 dB gain contours extend beyond the edge of the Earth*

EXHIBIT 4
TT&C Subsystem Characteristics

Beam Name	Command 1 Omni / WCA	Command 1 Global	Command 1 Global	Command 2 Omni / WCA	Command 2 Global	Command 2 Global
Schedule S Beam ID	CMD1	CMD2	CMD3	CMD4	CMD5	CMD6
Frequencies (MHz)[1]	6424.5	6424.5	6424.5	6421.5	6421.5	6421.5
Polarization	RHCP	Horizontal	Vertical	RHCP	Horizontal	Vertical
Peak Flux Density at Command Threshold (dBW/m^2-Hz)	-115	-115	-115	-115	-115	-115

Beam Name	Telemetry 1 Omni	Telemetry 1 Global	Telemetry 1 Global	Telemetry 1 WCA	ULPC Dish
Schedule S Beam ID	TLMA	TLMB	TLMC	TLMD	UPC1
Frequencies (MHz)[2]	4199.75	4199.75	4199.75	4199.75	4199.95
Polarization	LHCP	Horizontal	Vertical	Vertical	RHCP
Maximum Channel EIRP (dBW)	8	8	8	8	9
Maximum Beam Peak EIRP Density (dBW/4kHz)	-11.40	-11.40	-11.40	-11.40	1
Maximum Beam Peak EIRP Density (dBW/Hz)	-47.4	-47.4	-47.4	-47.4	-35

Beam Name	Telemetry 2 Omni	Telemetry 2 Global	Telemetry 2 Global	Telemetry 2 WCA
Schedule S Beam ID	TLME	TLMF	TLMG	TLMH
Frequencies (MHz)[3]	4198.75	4198.75	4198.75	4198.75
Polarization	LHCP	Horizontal	Vertical	LHCP
Maximum Channel EIRP (dBW)	8	8	8	8
Maximum Beam Peak EIRP Density (dBW/4kHz)	-11.40	-11.40	-11.40	-11.40
Maximum Beam Peak EIRP Density (dBW/Hz)	-47.4	-47.4	-47.4	-47.4

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1 The center frequencies given are representative. *See* § 2.3.

2 *Id.*

3 *Id.*